

What is claimed is:

1 1. A method for making a protected MEMS structure, comprising the steps of:
2 (a) preparing a MEMS wafer having a plurality of MEMS structure sites thereon;
3 (b) mounting, upon the MEMS wafer, a spacer layer, the spacer layer being perforated in
4 areas corresponding to locations of the MEMS structure sites on the MEMS wafer; and
5 (c) mounting, upon the spacer layer, a wafer cap to produce a laminated MEMS wafer,
6 the spacer layer having a height to prevent electrostatically induced damage to the MEMS wafer.

1 2. The method as claimed in claim 1, wherein the spacer layer comprises a tape having
2 adhesive on two sides and a flexible film.

1 3. The method as claimed in claim 1, wherein the spacer layer comprises a flexible film
2 with an adhesive medium on one side.

1 4. The method as claimed in claim 2, wherein the flexible film is transmissive to UV
2 radiation.

1 5. The method as claimed in claim 3, wherein the flexible film is transmissive to UV
2 radiation.

1 6. The method as claimed in claim 1, wherein the wafer cap is a cover tape.

1 7. The method as claimed in claim 1, wherein the cover tape comprises a static
2 dissipative material.

1 8. The method as claimed in claim 2, wherein the wafer cap is a cover tape.

1 9. The method as claimed in claim 3, wherein the wafer cap is a cover tape.

1 10. The method as claimed in claim 4, wherein the wafer cap is a cover tape.

1 11. The method as claimed in claim 5, wherein the wafer cap is a cover tape.

1 12. The method as claimed in 1, wherein the height of the spacer layer prevents the
2 wafer cap from deflecting in such a manner to come in contact with the MEMS structures.

1 13. The method as claimed in 2, wherein the height of the spacer layer prevents the
2 wafer cap from deflecting in such a manner to come in contact with the MEMS structures.

1 14. The method as claimed in 3, wherein the height of the spacer layer prevents the
2 wafer cap from deflecting in such a manner to come in contact with the MEMS structures.

1 15. The method as claimed in 4, wherein the height of the spacer layer prevents the
2 wafer cap from deflecting in such a manner to come in contact with the MEMS structures.

1 16. The method as claimed in 5, wherein the height of the spacer layer prevents the
2 wafer cap from deflecting in such a manner to come in contact with the MEMS structures.

1 17. The method as claimed in 6, wherein the height of the spacer layer prevents the
2 wafer cap from deflecting in such a manner to come in contact with the MEMS structures.

1 18. The method as claimed in 7, wherein the height of the spacer layer prevents the
2 wafer cap from deflecting in such a manner to come in contact with the MEMS structures.

1 19. The method as claimed in 8, wherein the height of the spacer layer prevents the
2 wafer cap from deflecting in such a manner to come in contact with the MEMS structures.

1 20. The method as claimed in 9, wherein the height of the spacer layer prevents the
2 wafer cap from deflecting in such a manner to come in contact with the MEMS structures.

1 21. The method as claimed in 10, wherein the height of the spacer layer prevents the
2 wafer cap from deflecting in such a manner to come in contact with the MEMS structures.

1 22. The method as claimed in 11, wherein the height of the spacer layer prevents the
2 wafer cap from deflecting in such a manner to come in contact with the MEMS structures.

1 23. The method as claimed in claim 2, wherein the flexible film is about 40 mils thick.

1 24. The method as claimed in claim 1, wherein the spacer layer comprises a plurality of
2 layers of perforated tape, an aggregate of the plurality of layers of perforated tape producing the
3 height to prevent electrostatically induced damage to the MEMS wafer.

1 25. The method as claimed in claim 2, wherein the flexible film and tape are combined
2 and then cut to produce areas corresponding to the MEMS structures on the MEMS wafer.

1 26. The method as claimed in claim 2, wherein the flexible film and tape are combined
2 and then cut by a laser to produce areas corresponding to the MEMS structures on the MEMS
3 wafer.

1 27. The method as claimed in claim 2, wherein the flexible film and tape are combined
2 and then punched to produce areas corresponding to the MEMS structures on the MEMS wafer.

1 28. The method as claimed in claim 2, wherein the flexible film and tape are pre-cut to
2 produce areas corresponding to the MEMS structures on the MEMS wafer before being
3 combined.

1 29. The method as claimed in claim 2, wherein the flexible film and tape are pre-
2 punched to produce areas corresponding to the MEMS structures on the MEMS wafer before
3 being combined.

1 30. The method as claimed in claim 25, wherein the flexible film and tape are combined
2 using pressure to promote adhesion.

1 31. A method for making a protected MEMS structure, comprising the steps of:
2 (a) preparing a MEMS wafer having a plurality of MEMS structure sites thereon;
3 (b) mounting, upon the MEMS wafer, a spacer layer, the spacer layer being perforated in
4 areas corresponding to locations of the MEMS structure sites on the MEMS wafer; and
5 (c) mounting, upon the spacer layer, a wafer cap to produce a laminated MEMS wafer,
6 the spacer layer having a height to prevent damage to the MEMS structures due to the wafer cap
7 coming into physical contact with the MEMS wafer.

1 32. The method as claimed in claim 31, wherein the spacer layer comprises a tape having
2 adhesive on two sides and a flexible film.

1 33. The method as claimed in claim 31, wherein the spacer layer comprises a flexible
2 film with an adhesive medium on one side.

1 34. The method as claimed in claim 32, wherein the flexible film is transmissive to UV
2 radiation.

1 35. The method as claimed in claim 33, wherein the flexible film is transmissive to UV
2 radiation.

1 36. The method as claimed in claim 31, wherein the wafer cap is a cover tape.

1 37. The method as claimed in claim 31, wherein the cover tape comprises a static
2 dissipative material.

1 38. The method as claimed in claim 32, wherein the wafer cap is a cover tape.

1 39. The method as claimed in claim 33, wherein the wafer cap is a cover tape.

1 40. The method as claimed in claim 34, wherein the wafer cap is a cover tape.

1 41. The method as claimed in claim 35, wherein the wafer cap is a cover tape.

1 42. The method as claimed in claim 32, wherein the flexible film is about 40 mils thick.

1 43. The method as claimed in claim 31, wherein the spacer layer comprises a plurality of
2 layers of perforated tape, an aggregate of the plurality of layers of perforated tape producing the
3 height to prevent damage to the MEMS structures due to the wafer cap coming into physical
4 contact with the MEMS wafer.

1 44. The method as claimed in claim 32, wherein the flexible film and tape are combined
2 and then cut to produce areas corresponding to the MEMS structures on the MEMS wafer.

1 45. The method as claimed in claim 32, wherein the flexible film and tape are combined
2 and then cut by a laser to produce areas corresponding to the MEMS structures on the MEMS
3 wafer.

1 46. The method as claimed in claim 32, wherein the flexible film and tape are combined
2 and then punched to produce areas corresponding to the MEMS structures on the MEMS wafer.

1 47. The method as claimed in claim 32, wherein the flexible film and tape are pre-cut to
2 produce areas corresponding to the MEMS structures on the MEMS wafer before being
3 combined.

1 48. The method as claimed in claim 44, wherein the flexible film and tape are pre-
2 punched to produce areas corresponding to the MEMS structures on the MEMS wafer before
3 being combined.

1 49. The method as claimed in claim 25, wherein the flexible film and tape are combined
2 using pressure to promote adhesion.

1 50. A method for making a protected MEMS structure, comprising the steps of:
2 (a) preparing a MEMS wafer having a plurality of MEMS structure sites thereon;
3 (b) mounting, upon the MEMS wafer, a spacer layer, the spacer layer being perforated in
4 areas corresponding to locations of the MEMS structure sites on the MEMS wafer; and
5 (c) mounting, upon the spacer layer, a wafer cap to produce a laminated MEMS wafer,
6 the spacer layer having a height to prevent electrostatically induced damage to the MEMS wafer
7 and to prevent damage to the MEMS structures due to the wafer cap coming into physical
8 contact with the MEMS wafer.

1 51. The method as claimed in claim 50, wherein the spacer layer comprises a tape having
2 adhesive on two sides and a flexible film.

1 52. The method as claimed in claim 50, wherein the spacer layer comprises a flexible
2 film with an adhesive medium on one side.

1 53. The method as claimed in claim 51, wherein the flexible film is transmissive to UV
2 radiation.

1 54. The method as claimed in claim 52, wherein the flexible film is transmissive to UV
2 radiation.

1 55. The method as claimed in claim 50, wherein the wafer cap is a cover tape.

1 56. The method as claimed in claim 50, wherein the cover tape comprises a static
2 dissipative material.

1 57. The method as claimed in claim 51, wherein the wafer cap is a cover tape.

1 58. The method as claimed in claim 52, wherein the wafer cap is a cover tape.

1 59. The method as claimed in claim 53, wherein the wafer cap is a cover tape.

1 60. The method as claimed in claim 54, wherein the wafer cap is a cover tape

1 61. The method as claimed in claim 51, wherein the flexible film is about 40 mils thick.

1 62. The method as claimed in claim 50, wherein the spacer layer comprises a plurality of
2 layers of perforated tape, an aggregate of the plurality of layers of perforated tape producing the
3 height to prevent electrostatically induced damage to the MEMS wafer and to prevent damage to
4 the MEMS structures due to the wafer cap coming into physical contact with the MEMS wafer.

1 63. The method as claimed in claim 51, wherein the flexible film and tape are combined
2 and then cut to produce areas corresponding to the MEMS structures on the MEMS wafer.

1 64. The method as claimed in claim 51, wherein the flexible film and tape are combined
2 and then cut by a laser to produce areas corresponding to the MEMS structures on the MEMS
3 wafer.

1 65. The method as claimed in claim 51, wherein the flexible film and tape are combined
2 and then punched to produce areas corresponding to the MEMS structures on the MEMS wafer.

1 66. The method as claimed in claim 51, wherein the flexible film and tape are pre-cut to
2 produce areas corresponding to the MEMS structures on the MEMS wafer before being
3 combined.

1 67. The method as claimed in claim 51, wherein the flexible film and tape are pre-
2 punched to produce areas corresponding to the MEMS structures on the MEMS wafer before
3 being combined.

1 68. The method as claimed in claim 63, wherein the flexible film and tape are combined
2 using pressure to promote adhesion.

1 69. The method as claimed in claim 1, further comprising the step of:
2 (d) applying a contiguous tape on a backside of the MEMS wafer, the backside of the
3 MEMS wafer being a side opposite of a side having the wafer cap located thereon.

1 70. The method as claimed in claim 69, wherein the contiguous tape is applied to a
2 backside of the MEMS wafer after the wafer cap is mounted on the MEMS wafer.

1 71. The method as claimed in claim 69, wherein the contiguous tape is applied to a
2 backside of the MEMS wafer before the wafer cap is mounted on the MEMS wafer.

1 72. The method as claimed in claim 69, wherein the contiguous tape is applied to a
2 backside of the MEMS wafer before the laminated MEMS wafer is sawn.

1 73. The method as claimed in claim 31, further comprising the step of:
2 (d) applying a contiguous tape on a backside of the MEMS wafer, the backside of the
3 MEMS wafer being a side opposite of a side having the wafer cap located thereon.

74. The method as claimed in claim 73, wherein the contiguous tape is applied to a
backside of the MEMS wafer after the wafer cap is mounted on the MEMS wafer.

75. The method as claimed in claim 73, wherein the contiguous tape is applied to a
backside of the MEMS wafer before the wafer cap is mounted on the MEMS wafer.

76. The method as claimed in claim 73, wherein the contiguous tape is applied to a
backside of the MEMS wafer before the laminated MEMS wafer is sawn.

1 77. The method as claimed in claim 50, further comprising the step of:
2 (d) applying a contiguous tape on a backside of the MEMS wafer, the backside of the
3 MEMS wafer being a side opposite of a side having the wafer cap located thereon.

1 78. The method as claimed in claim 77, wherein the contiguous tape is applied to a
2 backside of the MEMS wafer after the wafer cap is mounted on the MEMS wafer.

1 79. The method as claimed in claim 77, wherein the contiguous tape is applied to a
2 backside of the MEMS wafer before the wafer cap is mounted on the MEMS wafer.

1 80. The method as claimed in claim 77, wherein the contiguous tape is applied to a
2 backside of the MEMS wafer before the laminated MEMS wafer is sawn.

1 81. A laminated MEMS wafer, comprising:
2 a MEMS wafer having a plurality of MEMS structure sites located thereon;

3 a spacer layer mounted upon the MEMS wafer, the spacer layer being perforated in areas
4 corresponding to locations of the MEMS structure sites on the MEMS wafer; and
5 a wafer cap mounted upon said spacer layer to produce a laminated MEMS wafer;
6 said spacer layer having a height to prevent electrostatically induced damage to said
7 MEMS wafer.

1 82. The laminated MEMS wafer as claimed in claim 81, wherein said spacer layer
2 comprises a tape having adhesive on two sides and a flexible film.

1 83. The laminated MEMS wafer as claimed in claim 81, wherein said spacer layer
2 comprises a flexible film with an adhesive medium on one side.

1 84. The laminated MEMS wafer as claimed in claim 82, wherein said flexible film is
transmissive to UV radiation.

1 85. The laminated MEMS wafer as claimed in claim 83, wherein said flexible film is
transmissive to UV radiation.

1 86. The laminated MEMS wafer as claimed in claim 81, wherein said wafer cap is a
cover tape.

1 87. The laminated MEMS wafer as claimed in 81, wherein the height of said spacer layer
2 prevents said wafer cap from deflecting in such a manner to come in contact with the MEMS
3 structures.

1 88. The laminated MEMS wafer as claimed in 86, wherein the height of said spacer layer
2 prevents said wafer cap from deflecting in such a manner to come in contact with the MEMS
3 structures.

1 89. The laminated MEMS wafer as claimed in claim 82, wherein said flexible film is
2 about 40 mils thick.

1 90. The laminated MEMS wafer as claimed in claim 81, wherein said spacer layer
2 comprises a plurality of layers of perforated tape, an aggregate of the plurality of layers of
3 perforated tape producing the height to prevent electrostatically induced damage to said MEMS
4 wafer.

1 91. The laminated MEMS wafer as claimed in claim 82, wherein said flexible film and
2 tape are combined and then cut to produce areas corresponding to the MEMS structures on said
3 MEMS wafer.

1 92. The laminated MEMS wafer as claimed in claim 82, wherein said flexible film and
2 tape are combined and then punched to produce areas corresponding to the MEMS structures on
3 said MEMS wafer

1 93. The laminated MEMS wafer as claimed in claim 82, wherein said flexible film and
2 tape are pre-cut to produce areas corresponding to the MEMS structures on said MEMS wafer
3 before being combined.

1 94. The laminated MEMS wafer as claimed in claim 82, wherein said flexible film and
2 tape are pre-punched to produce areas corresponding to the MEMS structures on said MEMS
3 wafer before being combined.

1 95. The laminated MEMS wafer as claimed in claim 91, wherein said flexible film and
2 tape are combined using pressure to promote adhesion.

1 96. A laminated MEMS wafer, comprising:
2 a MEMS wafer having a plurality of MEMS structure sites located thereon;
3 a spacer layer mounted upon the MEMS wafer, the spacer layer being perforated in areas
4 corresponding to locations of the MEMS structure sites on the MEMS wafer; and
5 a wafer cap mounted upon said spacer layer to produce a laminated MEMS wafer;
6 said spacer layer having a height to prevent damage to the MEMS structures due to said
7 wafer cap coming into physical contact with said MEMS wafer.

1 97. The laminated MEMS wafer as claimed in claim 96, wherein said spacer layer
2 comprises a tape having adhesive on two sides and a flexible film.

1 98. The laminated MEMS wafer as claimed in claim 96, wherein said spacer layer
2 comprises a flexible film with an adhesive medium on one side.

1 99. The laminated MEMS wafer as claimed in claim 97, wherein said flexible film is
2 transmissive to UV radiation.

1 100. The laminated MEMS wafer as claimed in claim 98, wherein said flexible film is
2 transmissive to UV radiation.

1 101. The laminated MEMS wafer as claimed in claim 96, wherein said wafer cap is a
2 cover tape.

1 102. The laminated MEMS wafer as claimed in claim 97, wherein said flexible film is
2 about 40 mils thick.

1 103. The laminated MEMS wafer as claimed in claim 96, wherein said spacer layer
2 comprises a plurality of layers of perforated tape, an aggregate of the plurality of layers of
3 perforated tape producing the height to prevent damage to the MEMS structures due to said
4 wafer cap coming into physical contact with said MEMS wafer.

104. The laminated MEMS wafer as claimed in claim 97, wherein said flexible film and
tape are combined and then cut to produce areas corresponding to the MEMS structures on said
MEMS wafer.

105. The laminated MEMS wafer as claimed in claim 97, wherein said flexible film and
tape are combined and then punched to produce areas corresponding to the MEMS structures on
said MEMS wafer.

1 106. The laminated MEMS wafer as claimed in claim 97, wherein said flexible film and
2 tape are pre-cut to produce areas corresponding to the MEMS structures on said MEMS wafer
3 before being combined.

1 107. The laminated MEMS wafer as claimed in claim 97, wherein said flexible film and
2 tape are pre-punched to produce areas corresponding to the MEMS structures on said MEMS
3 wafer before being combined.

1 108. The laminated MEMS wafer as claimed in claim 104, wherein said flexible film and
2 tape are combined using pressure to promote adhesion.

1 109. A laminated MEMS wafer, comprising:
2 a MEMS wafer having a plurality of MEMS structure sites located thereon;

3 a spacer layer mounted upon the MEMS wafer, the spacer layer being perforated in areas
4 corresponding to locations of the MEMS structure sites on the MEMS wafer; and
5 a wafer cap mounted upon said spacer layer to produce a laminated MEMS wafer;
6 said spacer layer having a height to prevent damage to the MEMS structures due to said
7 wafer cap coming into physical contact with said MEMS wafer and to prevent electrostatically
8 induced damage to said MEMS wafer.

1 110. The laminated MEMS wafer as claimed in claim 109, wherein said spacer layer
2 comprises a tape having adhesive on two sides and a flexible film.

1 111. The laminated MEMS wafer as claimed in claim 109, wherein said spacer layer
2 comprises a flexible film with an adhesive medium on one side.

1 112. The laminated MEMS wafer as claimed in claim 110, wherein said flexible film is
2 transmissive to UV radiation.

1 113. The laminated MEMS wafer as claimed in claim 111, wherein said flexible film is
2 transmissive to UV radiation.

1 114. The laminated MEMS wafer as claimed in claim 109, wherein said wafer cap is a
2 cover tape.

1 115. The laminated MEMS wafer as claimed in claim 110, wherein said flexible film is
2 about 40 mils thick.

1 116. The laminated MEMS wafer as claimed in claim 109, wherein said spacer layer
2 comprises a plurality of layers of perforated tape, an aggregate of the plurality of layers of
3 perforated tape producing the height to prevent damage to the MEMS structures due to said
4 wafer cap coming into physical contact with said MEMS wafer and to prevent electrostatically
5 induced damage to said MEMS wafer.

1 117. The laminated MEMS wafer as claimed in claim 110, wherein said flexible film and
2 tape are combined and then cut to produce areas corresponding to the MEMS structures on said
3 MEMS wafer

1 118. The laminated MEMS wafer as claimed in claim 110, wherein said flexible film and
2 tape are combined and then punched to produce areas corresponding to the MEMS structures on
3 said MEMS wafer.

1 119. The laminated MEMS wafer as claimed in claim 110, wherein said flexible film and
2 tape are pre-cut to produce areas corresponding to the MEMS structures on said MEMS wafer
3 before being combined.

1 120. The laminated MEMS wafer as claimed in claim 110, wherein said flexible film and
2 tape are pre-punched to produce areas corresponding to the MEMS structures on said MEMS
3 wafer before being combined.

1 121. The laminated MEMS wafer as claimed in claim 117, wherein said flexible film and
2 tape are combined using pressure to promote adhesion.

1 122. The method as claimed in claim 1, wherein the wafer cap comprises a static
2 dissipative material.

1 123. The method as claimed in claim 1, wherein the spacer layer comprises a static
2 dissipative material.

1 124. The method as claimed in claim 31, wherein the wafer cap comprises a static
2 dissipative material.

1 125. The method as claimed in claim 31, wherein the spacer layer comprises a static
2 dissipative material.

1 126. The method as claimed in claim 50, wherein the wafer cap comprises a static
2 dissipative material.

1 127. The method as claimed in claim 50, wherein the spacer layer comprises a static
2 dissipative material.

1 128. The method as claimed in claim 69, wherein the contiguous tape comprises a static
2 dissipative material.

1 129. The method as claimed in claim 73, wherein the contiguous tape comprises a static
2 dissipative material.

1 130. The method as claimed in claim 77, wherein the contiguous tape comprises a static
2 dissipative material.

1 131. The laminated MEMS wafer as claimed in claim 81, wherein the wafer cap
2 comprises a static dissipative material.

1 132. The laminated MEMS wafer as claimed in claim 81, wherein the spacer layer
2 comprises a static dissipative material.

1 133. The laminated MEMS wafer as claimed in claim 96, wherein the wafer cap
2 comprises a static dissipative material

1 134. The laminated MEMS wafer as claimed in claim 96, wherein the spacer layer
2 comprises a static dissipative material.

1 135. The laminated MEMS wafer as claimed in claim 109, wherein the wafer cap
2 comprises a static dissipative material.

1 136. The laminated MEMS wafer as claimed in claim 109, wherein the spacer layer
2 comprises a static dissipative material.

1 137. The method as claimed in claim 69, wherein the contiguous tape is applied to the
2 backside of the MEMS wafer after the laminated MEMS wafer is sawn.

1 138. The method as claimed in claim 73, wherein the contiguous tape is applied to the
2 backside of the MEMS wafer after the laminated MEMS wafer is sawn.

1 139. The method as claimed in claim 77, wherein the contiguous tape is applied to the
2 backside of the MEMS wafer after the laminated MEMS wafer is sawn.

1 140. The laminated MEMS wafer as claimed in claim 81, further comprising:
2 a contiguous tape applied to a backside of said MEMS wafer, the backside of said MEMS
3 wafer being a side opposite of a side having said wafer cap located thereon

1 141. The laminated MEMS wafer as claimed in claim 140, wherein said contiguous tape
2 is applied to the backside of said MEMS wafer after the laminated MEMS wafer is sawn.

1 142. The laminated MEMS wafer as claimed in claim 96, further comprising:
2 a contiguous tape applied to a backside of said MEMS wafer, the backside of said MEMS
3 wafer being a side opposite of a side having said wafer cap located thereon.

1 143. The laminated MEMS wafer as claimed in claim 142, wherein said contiguous tape
2 is applied to the backside of said MEMS wafer after the laminated MEMS wafer is sawn.

1 144. The laminated MEMS wafer as claimed in claim 109, further comprising:
2 a contiguous tape applied to a backside of said MEMS wafer, the backside of said MEMS
3 wafer being a side opposite of a side having said wafer cap located thereon.

145. The laminated MEMS wafer as claimed in claim 144, wherein said contiguous tape
is applied to the backside of said MEMS wafer after the laminated MEMS wafer is sawn.

FIG. 10 is a cross-sectional view of the MEMS wafer of FIG. 9.